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Skunk Cabbage Flowers: The Heat is On

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Journeying into the Cypress Bridge Forest

Rare ancient forest explored

In October of last year, a hearty group of VNPS members as well as others interested in exploring unique habitats ventured into the swamps of the ancient Cypress Bridge Forest. About 14 "explorers" participated and the three-hour walk passed very quickly. The International Paper Company, Inc. owns the property, and at the time of the walk, the Virginia Department of Conservation and Recreation was negotiating purchase of the tract from that company. It is highly likely that negotiations will be successful.

The starting point for the Cypress Bridge Forest field trip was at the remnants

(See The ancients, page 4)

Skunk cabbage flowers: The heat is on!

It is a remarkable sight, as striking as it is unexpected: January skunk cabbages emerging from the frozen mires they call home, melting their way through snow and ice. It seems so improbable because in everyday experience plants exist at equilibrium with ambient temperatures. Leave an apple on the front seat of your car in summer, it gets hot; examine your tomato plants on that first frosty morning in autumn, and they are permeated with ice crystals. People, mammals and birds are inherently warm, and pretty much nothing else is. Except, of course, for the exceptions, of which skunk cabbage is one.

Skunk cabbages are thermogenic, meaning that they produce their own heat. They do this in roughly the same way that people, mammals and birds maintain their body temperature, by the biochemical breakdown of food / fuel molecules in individual cells, and by insulation of some sort to minimize loss of whatever heat they can muster. The simple sugar glucose serves as food / fuel for both plant and animal cells in a process called cellular respiration. Overall, the process of cell respiration is fairly complex but a few highlights will assist in understanding what is going on inside those cozy little skunk cabbages in the dead of winter.

(See Snow melting, page 2)

From the president . . . . . .

Think 'Habitat' when heading outdoors

Brrrrr! It's mid winter (the weather report is showing people in Minneapolis using bananas for hammers). Many of you can rush right out to see this year's honored native plant, ***Symplocarpus feotidus*** *or skunk cabbage. Here in the coldest part of the state, it's going to be a while.*

It is time for planning the coming year, and several events are listed on the back page of this newsletter. Grab your calendar and join in.

A statewide invasive plant removal day is being planned by the Virginia Master Naturalists for May 2, and at our last board meeting, the chapter presidents showed interest in participating. We had a lively discussion about the date. Most of us feel that the work is better done at other times of year. But we also talked about the advantages of getting people out on a nice May day at a time when the plants are easier to recognize and to see in action, and how that might be a good introduction for those unfamiliar with the problem. Seen that way, an event in a populated area with high visibility could be very educational. And we need to educate – we will wear ourselves out and have little to show for it if we try to remove invasives without stopping some of them at their gardening source. We will try to have more information in our next issue.

Speaking about invasive plants can be a touchy subject, since many gardeners have their favorite invasive plant and they are not happy to let go of it. Perhaps speaking about the positives of habitat is a better way to begin. I got that thought and this quote from a class announcement that came to me via Kathi Mestayer, John Clayton Chapter and state board member: ***"....the outdoors is habitat whether we think of it that way or not. That puddle in the sidewalk the birds seem to prefer to the birdbath, the fireflies flashing in unison in summer, the box turtle crossing Strawberry Plains Road – they're all dealing with the resources (and obstacles) of their habitats. And we, as humans. . .have a significant impact on them."***

Rather than putting out plants and moving them around like so many pieces of furniture, encourage people to notice that the plants are alive and working to produce the energy that supports everything else.

Your President, Sally Anderson

Snow melting ability rare in the plant world

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First, it is important to realize that the chemical bonds of glucose represent stored energy and as these bonds are broken during cell respiration, some of that energy is diverted to another molecule called Adenosine triphosphate (ATP), but some is simply lost, dissipating from the reacting molecules as heat. We often view the production of ATP as primary, because cells use ATP to accomplish all manner of necessary biochemical activities. Heat loss is often viewed as an unavoidable outcome of burning sugar to make ATP. Ultimately, however, metabolic heat released from the breakdown of glucose is how skunks, skunk cabbages, and you and I stay warm.

Of course, glucose for heat production in skunk cabbage is part of a much larger cycle. Energy from sunlight is used to make glucose in the leaves via photosynthesis during the summer. This sugar is then transported to the thick underground rhizome and stored as starch where it sits until flowering time; then, starch is broken down to yield sugar that is transported to the flower cluster (spadix), where it is burned, in large part, to produce heat. In a sense, it is last summer's sunlight that melts the snow and ice around flowering skunk cabbages.

As it turns out, certain details of thermogenic (heat-producing) respiration in skunk cabbage are radically different from the process that occurs in animals. Signifi-

(See Skunk cabbage, page 6)

The flowers of this skunk cabbage are melting the snow on top. (Photo by John Hayden)

•Skunk cabbage

(Continued from page 2)

cantly, cell respiration in animals can be poisoned by cyanide, but thermogenic respiration in skunk cabbages is cyanide resistant. What we would consider a lethal dose of cyanide has scarcely any impact at all on heat production in the lowly skunk cabbage. Cyanide resistance occurs because this plant has an alternative biochemical pathway that, in effect, goes around the steps impaired by cyanide. This alternative pathway, however, fails to provide the cell with the ATP that would have been made via the cyanide-sensitive route. Careful study suggests that most cell respiration in skunk cabbage flower clusters follows the cyanide-resistant path, even in the absence of cyanide (which, of course, is the usual situation out in the swamp), suggesting that production of heat rather than ATP is the primary function of the process, at least in the flower clusters.

One study reports spadix temperatures 15 to 35 C above ambient for a period of two weeks when the ambient temperature ranged from –15 to +15 C. Rates of respiration measured in that study were described as comparable to that of a small mammal of equivalent mass. Unlike a mammal, though, the skunk cabbage spadix does not achieve thermal stability; its temperature rises and falls with ambient temperature but will generally stay elevated above ambient. There is, however, some degree of regulation, demonstrated by the fact that respiratory rates increase with decreasing ambient temperatures. But there are limits. Several days at –5 C or single nights at –10 or –15 C can result in cessation of heat production and freezing of the spadix. Also, very little food / fuel for respiration resides within the spadix itself; when severed from the rhizome, spadix temperatures quickly return to ambient levels.

Skunk cabbage is not unique in its thermogenic capacity. Several members of the arum family (Araceae) to which skunk cabbage belongs have heat-producing spadices, even among tropical species. Also, certain South American night-blooming water lilies (*Nymphaea* species) elevate flower temperatures above ambient levels as part of a complex pollination symbiosis with scarab beetles. Beyond these few examples, though, the phenomenon appears to be quite rare. It is interesting to note that cyanide-resistant respiration, upon which plant thermogenicity is based, is relatively widespread among non-thermogenic plants but its purpose in those species remains obscure.

Four hypotheses have been advanced to explain the adaptive significance of thermogenicity in skunk cabbage: 1) protection of the flowers from freezing; 2) acceleration of development to allow early season flowering; 3) attraction of pollinators by vaporizing scent molecules or by release of carbon dioxide; and 4) providing heat as an attractant or reward (or both) for insect pollinators. Pollination-related explanations are most often-mentioned in casual literature about skunk cabbages but perusal of the scientific literature reveals a paucity of information on the subject. A few bees, beetles, and several kinds of flies have been documented inside skunk cabbage spathes, but whether any of these function as effective pollinators remains to be seen. A study of the Asian species, *Symplocarpus renifolius,* revealed few insects within spathes, overall low levels of pollination, and pollen detected on the bodies of just a single mosquito and a single beetle – certainly not a compelling case for an efficient pollination symbiosis. Obviously, much remains to be learned about the floral biology of skunk cabbages.

The literature on thermogenic respiration in skunk cabbage is surprisingly extensive; the following sources were consulted for this brief overview:

1. Knutson, R. M. 1972. Temperature measurements of the spadix of *Symplocarpus foetidus* (L.) Nutt. Amer. Midl. Nat. 88: 251-254.

2. Knutson, R. M. 1974. Heat production and temperature regulation in eastern skunk cabbage. Science 186: 746-747.

3. Seymour, R. S. and A. J. Baylock. 1999. Switching off the heater: influence of ambient temperature on thermoregulation by eastern skunk cabbage *Symplocarpus foetidus*. J. Exp. Bot. 50: 1525-1532.

4. Uemura, S., K. Ohkawara, G. Kudo, N. Wada, and S. Higashi. 1993. Heat production and cross-pollination of the Asian skunk cabbage *Symplocarpus renifolius* (Araceae). Amer. J. Bot. 80: 635-640.

--W. John Hayden, VNPS Botany Chair

•Flora

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tion and field manual of Virginia's 3,500 flora species. A gift of $4,000 will cover the cost of text preparation of one entire flora family. Work remains on 40 families out of the entire 200 plant families in Virginia. I would be happy to talk with you about the families that remain uncompleted at this time and we would note that flora family sponsorship with your name in the first edition of the book.

Who is waiting for this *Manual of the Flora of Virginia*? Students and teachers of ecology, botany in high school and college, and natural science in the lower grades; natural resource managers of public land; professionals who advise developers, legislators, and businesses about habitats, plants, preservation as well as YOU, the native plant and wildflower public interested in preserving Virginia's natural landscape, and many others who now have no Virginia specific source for what plants are in Virginia, where they can be seen, what they look like, what their habitats are like, and what threats exist to their future existence.

This important project brings to Virginians the botanical reference field manual that they have not had since 1762 when *Flora Virginica* was published in the Netherlands by Gronovius based on the herbarium of John Clayton of Gloucester, Virginia. That is the springboard to the anticipated publication of a **new** *Flora* for the Old Dominion.

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